horse' does not differ so essentially as our authors think from the 'fixed unit' conception of this number against which they protest so strenuously. And this fictitious operation is no more the essence of multiplication and division than it is of counting. Multiplication of integers is abbreviated addition. The product 'three times two' is the sum of three two's not, happily, the measure in terms of a primary undefined unit of something whose measure in terms of a secondary undefined unit is three, when the measure of the secondary unit itself in terms of this primary unit is two.

On the other hand, measuring in the ordinary sense—the process which leads to the representation of *continuous* magnitudes as lines or surfaces, in terms of some unit of measure—deserves all the prominence which our authors would give it in arithmetic. We do not mean measuring in the exact mathematical sense, of course, but the rough measuring of common life, in which the magnitude measured and the unit are always assumed to be commensurable.

Compared with counting, or even addition and multiplication, an operation which involves the use of an arbitrary unit, and the comparison of magnitudes by its aid, is artificial. But this metrical use of number is of immense practical importance and of great interest to any child mature enough to understand it. No doubt a child may use a twelve-inch rule to advantage when practicing multiplication and division of integers. Certainly such an aid is almost indispensable in learning fractions. Without it the fraction is more than likely to be a mere symbol to him, without exact meaning of any kind. 'Two-thirds' has a reality for the child who can interpret it as the measure of a line two inches long in terms of a unit three inches long, which it quite lacks for him who can only repeat that it is 'two times the third part of unity.' Mathematicians now define the fraction as the symbolic result of a division which cannot be actually effected, but that definition will not serve the purposes of elementary instruction. It is as certain that the fraction had a metrical origin as it is that the integer had not, and in learning fractions, as in learning integers, the child cannot do better than follow the experience of the race.

Our authors must, therefore, be credited with doing the cause of rational instruction in arithmetic a real service by laying the stress they do on this proper metrical use of number. Their chapters on the practical teaching of arithmetic, moreover, though unduly prolix, contain many excellent suggestions. It is a pity that a book in the main so sound in respect to practice should be wrong on fundamental points of theory. One can but regret that its authors did not take pains before writing it to read what mathematicians of the present century have had to say on the questions with which they meant to deal. Their conception of number might have been modified by the considerations which have led mathematicians to 'arithmetise' the higher analysis itself by replacing the original metrical definition of the irrational number by a purely arithmetical one. At all events their notions of certain mathematical concepts would not have been so crude; they would not have made such a use of mathematical terms as this: "Quantity, the unity measured, whether a 'collection of objects' or a physical whole, is *continuous*, an undefined how *much;* number as measuring value is discrete, how *many*."

H. B. Fine.

Princeton, December 31, 1895.

Experimental Farms. Reports for 1894. Printed by order of Parliament. Ottawa, 1895. 422 pp. 8°.

The direct application of scientific methods of investigation to practical questions has, perhaps, in no field found greater extension during the last decade on this continent than in agriculture.

The establishment of the experiment stations in connection with agricultural colleges in all our States by the Hatch Act of 1887 has revolutionized the possibilities of agricultural pursuits, and what this act did for the United States, Canada did the same year in perhaps a more efficient if not as extensive manner for its people. This greater efficiency we would attribute to the fact that the direction of the five experimental farms located in different parts of the country is concentrated in one director and one staff, thereby producing that unity of purpose which insures success.

There is considerable scientific interest in the present (8th) annual report, issued under the editorship of the able director, Prof. Wm. Saunders, who is acknowledged as ideally fitted for his position.

We can only refer to a few of the most interesting results reported:

Prof. Jas. W. Robertson, the agriculturist, gives an outline of comparative tests of pure cultures of bacteria in the ripening of cream, from which he deduces results of a most interesting nature, showing the practical application of science in butter making. It was found that the flavor of butter is largely determined by the bacteria which develop in milk and cream, and that the conditions favoring the most satisfactory development of such bacteria prevail in a perfectly clean, well ventilated dairy; the bacteria present in the atmosphere under such conditions being superior to any artificial cultures tested.

The Chemist, Prof. Frank T. Shutt, contributes a notable article on the chemistry of the apple, completing the record of an investigation begun in previous years. It appears from the tables accompanying this discussion that 1,000 pounds of the leaves of the apple contain, as an average of the results of analyses of four varieties, 7.42 pounds nitrogen, 2.45 pounds phosphoric acid and 2.52 pounds of potash, most of which is of course returned to the soil. Estimating the average crop of the four varieties analyzed at 160 barrels per acre, there is removed from each acre in every crop of fruit the following quantities of important fertilizing constituents: 8.952 pounds nitrogen, 5.228 pounds phosphoric acid, 32.808 pounds potash. The chemist then advises the turning under of a leguminous crop, wood ashes and barnyard manure as a means of restoring to the soil the elements removed in the fruit crop.

There is no unnecessary use of technical terms in this admirable paper, and the deductions are drawn so directly from laboratory results that the veriest tyro cannot fail to be impressed with the close relation of this science to agriculture. The chemistry of the strawberry plant and of copper-salt fungicides is also discussed.

The reports of the horticulturist, the entomologist and the poultry manager are of the same high order of practically applied science.

B. E. FERNOW.

Les Nouvelles Théories Chimiques. Par A. ÉTARD, Paris, G. Masson, et Gauthiers-Villars et fils. 12 mo., pp. 196.

This volume is one of a series, Encyclopédie Scientifique des Aide-Memoire, published under direction of M. Léauté, Membre de l' Institut.

The author aims to present, in brief outline, the principal chemical theories of the day. His book is divided into two parts. Part I. consists of three sections, containing in all six chapters. These are devoted to: Definitions and general principles; a discussion of the atomic and kinetic hypotheses; a consideration of the chemical properties of molecules dependent upon the three states of aggregation of matter—the solid, the liquid, the gaseous.

Part II. contains four chapters. The first of these refers to the relation between mechanics and chemistry; the others treat respectively of thermo-, photo- and electro-chemistry.

Concerning the nature of matter the author refers to the views held by some 'Dynamistes purs,' that matter has no actual existence, but that that which we term matter is rather a sort of illusion of our senses impressed by a group of factors depending on energy, space and time.

Matter, he says, can not be precisely defined; it is everything which has weight, which can be seen or felt. Chemistry is described as the science of the transformations experienced by matter.

It will be of interest to many to learn (p. 46) that A. E. Béguyer de Chancourtois in his Vis tellurique, classement des corps simples ou radicaux obtenu au moyen d'un système de classification hélicoïdal et numerique, Paris, 1863, is credited with being the first to have published a continuous classification of the elements arranged according to their atomic weights. It will be recalled that Newlands' first communication 'On Relations Among the Equivalents,' appeared in the Chemical News, February 7th, of the year mentioned.

Attention is also called to the various shortcomings of the Periodic Law, and the surmise is hazarded that perhaps some day this system